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Tool and method for cutting a hollow profile

The invention relates to a tool for cutting a hollow profile according to the preamble of claim 1 and to an associated method according to the preamble of claim 9.

DE 197 24 037 C2 discloses a method of cutting a hollow body. The method is based on the combined application of mechanical cutting along a first cutting edge and of internal high pressure cutting along a second cutting edge. In this case, the fact that the hollow body is deformed according to the internal high pressure forming process is utilized to the effect that the hollow body is severed transversely to its longitudinal extent preferably after internal high pressure forming has already been effected.

DE 100 30 882 A1 discloses a precision cutting method and an associated device. To this end, a punching strip, in a first embossing step, is supported against a fixed surface by means of at least one hold-down, and the subsequent finished part is pressed at the same time or with a time delay into an embossing die, preferably against the spring force of a spring base. In the process, a sliding surface is produced on the lateral surfaces of the subsequent finished part. In a second parting step following the embossing step, the punching strip is thereupon supported on a fixed surface by at least one hold-down and then the subsequent finished part is cut out with a parting punch in a parting die.

DE 199 01 304 A1 discloses a method of processing workpieces. In this case, essentially vertically moving processing tools are arranged at at least one station and

essentially horizontally moving processing tools are arranged at at least one further station, these processing tools acting on the workpieces. In the process, at least two workpieces preferably arranged axially symmetrically to one another and leaving a clearance space between them are processed simultaneously in each station. Furthermore, a device suitable for carrying out the method has been disclosed. The device, which is designed as a press tool for example, makes it possible, for example after the deep drawing of a sheet-metal workpiece, to carry out the cutting/perforating operations, following said deep drawing, on spatially differently oriented surfaces of the workpiece and thus increase the capacity of the device.

DE 40 35 938 A1 discloses a press tool with multiple movements, having a punch and die which are movable relative to one another due to the movement of the punch. Arranged opposite the punch inside the die is a counter punch which can be moved independently and with a variable force via hydraulic cylinders accommodated in the tool. In addition, or alternatively, a counter die is arranged opposite the die adjacent to the punch in the tool, this counter die likewise being movable independently and with a variable force via hydraulic cylinders accommodated in the tool. It is crucial in this case that the counter punch can be moved as part of the tool independently therefrom and with any desired and adjustable force, a factor which defines an additional movement. This counter punch is part of the tool, so a tool with multiple movements is now produced by the additional movement.

DE 101 36 792 A1 discloses a tool for trimming drawn

parts.

The present invention deals with the problem of specifying a method for internal high pressure forming with which in particular a rationalized production process can be achieved. Furthermore, a tool suitable for the abovementioned method is to be provided with which in particular various method steps can be combined.

This problem is solved according to the invention by the subject matters of the independent claims. Advantageous embodiments are the subject matter of the dependent claims.

The invention is based on the general idea of designing a tool both for cutting a flange on a hollow profile and for forming the hollow profile according to the internal high pressure forming process, the tool having at least one cutting device which is displaceable in the transverse direction of the hollow profile and runs parallel to the longitudinal extent. A side of the cutting device facing the hollow profile is in this case designed as a shaping die wall, against which the hollow profile bears after the cutting operation and during the internal high pressure forming following said cutting operation.

With a cutting edge formed on the cutting device, the tool according to the invention therefore at least partly cuts off a flange, running in the longitudinal direction of the hollow profile, parallel to the longitudinal direction by the cutting edge being displaced in the transverse direction of the hollow profile. After the flange has been cut off, that side of the device which

faces the hollow profile is utilized as a shaping die wall, against which the hollow profile then bears with an outer side during the internal high pressure forming. In this case, the tool according to the invention makes provision for a cutting operation on the hollow profile blank to be completed before the internal high pressure forming operation starts.

The solution according to the invention therefore offers the advantage that two method steps, namely the cutting of the flange and the subsequent internal high pressure forming, can be effected in one production step in a single tool, thereby resulting in a rationalized production sequence. The solution according to the invention therefore helps to streamline the production process and thus achieve time or cost advantages.

According to a development of the solution according to the invention, the tool has a bottom die and a top die which are displaceable relative to one another. In this case, either the cutting device is integrated in one of the dies and the cutting edge then forms an integral part of the respective die, or else the cutting edge is designed as a separate component and is fastened to one of the dies in a fixed position, or else the cutting device is arranged on one of the dies in such a way as to be adjustable in stroke. The variants described of the arrangement of the cutting device on the tool already shows the wide range of possibilities that the invention opens up with regard to process-optimized arrangement variants of the cutting devices. For example, a design of the cutting device as a separate component which is fastened to one of the dies in a fixed position offers the advantage that, after a relatively large number of

cutting operations, the cutting device or the cutting edge can be exchanged simply and quickly and thus the maintenance cost of the tool can be reduced. If the cutting device is arranged on one of the dies in such a way as to be adjustable in stroke, a markedly smoother mode of operation of the tool is obtained on account of the lower weight, to be moved, of the cutting device compared with the top or bottom die. On the other hand, the integration of the cutting device in one of the dies or the design of the cutting edge as an integral component offers the advantage that an especially precise and powerful cutting operation can be achieved as a result. Due to the many possible ways of arranging the cutting devices on one of the dies, the solution according to the invention therefore makes it possible to react in a flexible manner to the most varied requirements with regard to the material and/or workpiece to be processed.

According to a preferred embodiment of the invention, at least one hold-down, which fixes the flange of the hollow profile at least during the cutting operation, is provided in the region of the cutting edge. Such a hold-down, in combination with a positioning device which, before and during the cutting and forming operation, presses the hollow profile against that side of the cutting device which faces the hollow profile, ensures that the hollow profile is held in a fixed position during the cutting operation and thus ensures an exact cut of high quality. In addition, the hold-down provides for always identical positioning of the hollow profile inside the tool, as a result of which a high reproducible dimensional accuracy and thus uniformity of the hollow profiles to be produced is achieved.

An embossing punch may expediently be provided which is displaceable transversely to the longitudinal extent of the hollow profile and which makes an embossment on the outside of the hollow profile after the forming operation. In this way, the solution according to the invention, in addition to a cutting and internal high pressure forming operation, offers the advantage of carrying out an embossing operation virtually simultaneously, but in particular without a tool change, so that a further production step with the tool according to the invention can be integrated in the respective work station. In this case, the embossing punch may be arranged in such a way that it crosses and passes through the cutting device in a corresponding opening during the embossing operation. In the process, the embossing punch embosses an outer side, bearing against the die wall of the cutting device, of the hollow profile against the internal high pressure, a factor which leads to especially exact and dimensionally accurate embossing.

According to a further advantageous design of the solution according to the invention, at least one perforating punch is provided in the embossing punch coaxially thereto, this perforating punch perforating the hollow profile after the embossing operation has been completed. According to this embodiment, in addition to the cutting, internal high pressure forming, and embossing, the perforating can now also be integrated as a further processing step in the same tool, as a result of which time and cost advantages are again obtained. In addition, the solution according to the invention ensures that the holes produced by the perforating punch have a high accuracy of position and shape and thus the quality

of the hollow profiles produced can be markedly increased. Compared with previous production methods in which the holes are subsequently made in the already finish-shaped hollow profiles, subsequent deformation and thus dimensional inaccuracy of the hollow profile can now be avoided. Even in the opposite case in which the embossing is effected after the production of the holes, the solution according to the invention offers the great advantage that the embossing punch does not adversely affect the dimensional accuracy, that is to say the position and shape of the holes produced, by the embossing. In principle, with the tool according to the invention, first perforating and then embossing can be carried out after the internal high pressure forming, or vice versa.

Further important features and advantages of the invention follow from the subclaims, from the drawings and from associated description of the figures with respect to the drawings.

It goes without saying that the abovementioned features and the features still to be explained below can be used not only in the respectively specified combination but also in other combinations or on their own without departing from the scope of the present invention.

Preferred exemplary embodiments of the invention are shown in the drawings and are described in more detail below, identical reference numerals relating to identical or functionally identical or similar components.

In the drawing:

fig. 1 shows a cross section through a tool according to the invention with inserted hollow profile, before the cutting or forming operation,

fig. 2 shows an illustration as in fig.1, but with actuated positioning device,

fig. 3 shows a cross section through the tool according to the invention after the cutting and forming operation and before the embossing or perforating operation,

fig. 4 shows an illustration as in fig. 3 but with embossing and perforating operation completed,

fig. 5 shows a cross section through the tool with opened top and bottom die.

According to fig. 1, a tool 1 according to the invention, which is designed for cutting a flange 3 on a hollow profile 2, has a bottom die 7 and a top die 8, which are displaceable relative to one another. Here, according to the illustrations in figs 1 to 5, the top die 8 is displaceable toward the bottom die 7. In general, however, it is also conceivable for the bottom die 7 to be displaceable toward the top die 8 or for both to be mounted in an displaceable manner.

To cut the flange 3 on the hollow profile 2, the tool 1 has at least one cutting device 4, which runs parallel to the longitudinal extent, has a cutting edge 5 and is displaceable relative to the hollow profile in the transverse direction of the hollow profile 2. In this case, the cutting device 4 may be integrated in one of

the dies 7 or 8, the cutting edge 5 then forming an integral part of the respective die 7 or 8. Alternatively, the cutting device 4 may be also be designed as a separate component which is fastened on one of the two dies 7 or 8, here the top die 8, in a fixed position. As a third variant, the cutting device 4 may be arranged on one of the dies 7 or 8 in such a way as to be adjustable in stroke relative to the respective die 7, 8.

In the case of a cutting device 4 integrated in one of the dies 7 or 8, the flange 3 can be cut off or severed in an especially powerful and thus precise manner, as a result of which the quality of a subsequent end product can be markedly increased. On the other hand, the embodiment of the cutting device 4 as a separate component, which is fastened on one of the two dies 7 or 8 in a fixed position, offers the great advantage that the cutting edge 5, which may be designed, for example, as a parting blade, can be exchanged in a simple and cost-effective manner. Hardened metals, for example, which have an especially long service life, are suitable as cutting edge 5. The third embodiment variant, in which the cutting device 4 together with the cutting edge 5 is arranged in a displaceable manner on one of the dies 7 or 8, offers the advantage that the cutting operation can be isolated from a closing operation of the tool 1, i.e. from a movement of the top die 8 and the bottom die 7 toward one another.

According to fig. 1, a shaping die wall 17 is formed on a side 6 of the cutting device 4 facing the hollow profile 2, the hollow profile 2 bearing against this die wall 17 after the cutting operation and during the subsequent internal high pressure forming. In this case, according

to the illustrations in figs 1 to 5, the tool 1 is designed in cross section, for example, in such a way that the top die 8 and the bottom die 7 each have an L-shaped form, and these L-shaped forms, when they meet, form a cavity 14 in which the hollow profile 2 can be shaped by internal high pressure. This cavity 14 is in this case defined at least on one side by the die wall 17 of the cutting device 4.

According to fig. 1 and fig. 2, a positioning device 9 is provided on the tool 1, which positioning device 9, before the cutting and forming operation, presses the hollow profile 2 against that side 6 of the cutting device 4 which faces the hollow profile 2, that is to say against the die wall 17 of the cutting device 4. In this case, the positioning device 9 may be designed, for example, as a punch which is acted upon by spring force or hydraulic pressure and which is arranged so as to be extendable and retractable in one of the dies 7 or 8, here in the bottom die 7. According to fig. 2, the positioning device 9 is actuated and, in the actuated state, presses the hollow profile 2 against the side 6 of the cutting device 4.

Provided in the region of the cutting edge 5 is at least one hold-down 10 which fixes the flange 3 of the hollow profile 2 at least during the cutting operation. According to the illustrations in figs 3 and 4, a second hold-down 10' can also be provided by a stepped design of the cutting edge 5, this second hold-down 10' fixing the hollow profile 2 in position during the forming operation or embossing and perforating operation following the cutting operation.

According to the illustration in fig. 3, an embossing punch 11 is provided which is displaceable transversely to the longitudinal extent of the hollow profile 2 and provides an embossment (cf. fig. 4) on the outside of the hollow profile 2 after the forming operation. In this case, the embossing punch 11 can preferably be actuated hydraulically and acts during the embossing against an internal high pressure p_i which prevails inside the hollow profile 2. The embossing punch 11 may expediently be arranged in such a way that it crosses and passes through the cutting device 4 in a corresponding opening 12 after the cutting operation and during the embossing operation. During the cutting operation, the embossing punch 11 moves with the cutting device 4 or the top die 8 transversely to its embossing direction. It is conceivable in this case, for example, for an embossing surface 15 formed on the end face of the embossing punch 11 to be part of the shaping die wall 17 of the cutting device 4.

As mentioned above, the embossing of the hollow profile 2 is effected against the internal high pressure p_i and after the cutting operation, so that, with the embossing, an additional but facultative processing step can be carried out with the tool 1.

According to figs 3 and 4, at least one perforating punch 13, which perforates the hollow profile 2 after the completed embossing operation, is provided in the embossing punch 11 and coaxially thereto. An embossing direction of the embossing punch 11 is in this case parallel to a direction of movement of the perforating punch 13. Due to the tool according to the invention, a further likewise facultative processing step, namely the

perforating of the hollow profile 2, is integrated in the tool 1, as a result of which the production process per se can be greatly rationalized.

In addition, the embossing or the perforating against the internal high pressure p_i offers the advantage that embossments produced beforehand are not adversely affected by the perforating or perforations produced beforehand are not adversely affected by the embossing on account of the internal high pressure p_i, so that a high quality of the hollow profiles 2 produced can be achieved.

One possible method of cutting the hollow profile 2 or of forming, embossing and/or perforating the hollow profile 2 is to be briefly explained below:

According to fig. 1, the hollow profile 2 is inserted into the tool 1, the two dies 7 and 8 being in the open state, that is to say being positioned at a distance from one another. After the insertion of the hollow profile 2, which at this stage is still a hollow profile blank (not designated in any more detail), the positioning device 9, according to fig. 2, pushes the hollow profile 2, still before the cutting and forming operation, against that side 6 of the cutting device 4 which faces the hollow profile 2, that is to say against the die wall 17. During the positioning, the tool, according to fig. 2, is still in a partly open state, so that a simple adjustment of the hollow profile 2 in the direction of the cutting device 4 is possible.

The cutting operation is effected after the positioning. To this end, according to fig. 3, the top die 8 moves

towards the bottom die 7 and cuts off the flange 3 of the hollow profile 2 by means of the cutting edge 5, situated at the front on the cutting device 4 in the direction of movement. At least during the cutting operation, at least one hold-down 10 arranged in the region of the cutting edge 5 fixes the flange 3 of the hollow profile 2. After the cutting operation has been completed, a second hold-down 10' fixes the remaining flange stub of the hollow profile 2 and thus fixes the hollow profile 2 in its position. After the cutting operation, cutting scrap (not shown) falls through an ejection shaft 16, which according to figs 1 to 5 runs out vertically in the bottom die 7 in the direction of movement of the cutting device 4.

It can be seen from figs 2 and 3 that the cutting of the flange 3 is effected by the closing of the tool 1, that is to say by a movement of the top die 8 toward the bottom die 7. It is also conceivable in this case for the cutting operation to be effected only after the closing of the tool, that is to say when the top die 8 bears against the bottom die 7, by a cutting device 4 which is adjustable in stroke and is designed, for example, as a separate component.

After completion of the cutting operation, the hollow profile blank 2' is formed by internal high pressure forming and in the process changes in size and form in accordance with the illustration in fig. 3. During the internal high pressure forming, the positioning device 9 is actively shifted back or passively thrust back to a corresponding extent, that is to say the holding or positioning force of the positioning device 9 is (markedly) smaller than the forces which occur during the

forming and which widen the hollow profile 2.

After the forming of the hollow profile 2, an embossing punch 11 displaceable transversely to the longitudinal direction of the hollow profile 2 can make an embossment on the outside of the hollow profile 2 according to fig. 4. In this case, such an embossing operation is optionally selectable. Embossing is effected according to fig. 4 by the embossing punch 11 moving transversely to the longitudinal extent of the hollow profile 2 through the opening 12 in the cutting device 4 and embossing a recess in an outer wall of the hollow profile 2 by means of the embossing surface 15 provided at the front in the embossing direction.

In addition to or as an alternative to the embossing operation, a perforating punch 13 arranged in the embossing punch 11 coaxially thereto can perforate the hollow profile 2 after the embossing operation has been completed (cf. fig. 4). To this end, the perforating punch 13 travels transversely to the direction of movement of the cutting device 4 and parallel to the embossing direction of the embossing punch 11 and pierces an outer wall of the hollow profile 2. According to figs 3 and 4, in each case one perforating punch 13 is provided here. However, it is also possible for a plurality of perforating punches 13 to be arranged. It is also conceivable for perforating to be effected without embossing of the hollow profile 2. On account of the embossing punch 11 or perforating punch 13 acting against the internal high pressure p_i, it is possible to carry out both the embossing and the perforating on the hollow profile 2 without these processing steps adversely affecting one another as in a conventional method of

production in a plurality of steps.

In this case, the embossing surface 15 of the embossing punch 11, this embossing surface 15 being arranged by way of example in the opening 12 of the cutting device 4, may form part of that side 6 of the cutting device 4 which is designed as a shaping die wall 17. However, it is also conceivable for the opening 12 not to open until during an embossing or perforating operation and for it to be closed during the cutting operation or during the forming operation, as a result of which the shaping die wall 17 is formed completely by that side 6 of the cutting device 4 which faces the hollow profile 2.

According to fig. 5, the tool 1 is opened after the cutting and forming operation and/or embossing operation and/or perforating operation by the top die 8 moving away from the bottom die 7. In the process, the embossing punch 11 and also the perforating punch 13 are retracted into the tool 1 or the cutting device 4 at least to such an extent that the two dies 7 and 8 can move apart without any problems and the hollow profile 2 can be removed from the tool 1.

In summary, the essential features of the solution according to the invention can be characterized as follows:

In a tool 1 which is designed for cutting a flange 3 of a hollow profile 2 and for forming the hollow profile 2 according to the internal high pressure forming process, the invention makes provision for a cutting device 4 which has a cutting edge 5, runs parallel to the longitudinal extent and can be displaced in the

transverse direction of the hollow profile 2 and in which a side 6 of the cutting device facing the hollow profile 2 is designed as a shaping die wall 17, against which the hollow profile 2 bears during the internal high pressure forming after the cutting operation.

The invention thus enables a plurality of processing steps to be combined, for example the trimming, the forming, the embossing and the perforating of the hollow profile 2, in one production station, so that, with the tool 1 according to the invention, a plurality of processing steps hitherto separate from one another can be effected promptly and without removal of the hollow profile 2 from the tool 1. In addition, the processing steps of embossing and perforating can be carried out optionally, so that cutting of the flange 3 and subsequent forming and/or subsequent embossing and/or subsequent perforating can be carried out with the tool 1 according to the invention.

That side 6 of the cutting device 4 which is designed as a shaping die wall 17 provides for multifunctional use of the cutting device 4, the cutting device 4 being simple to realize from the design point of view and at the same time constituting an especially successful design solution. In addition, due to the embossing punch 11 or perforating punch 13 acting against the internal high pressure p_i, exact embossing or perforating of the hollow profile 2 can be effected, during which the embossing and the perforating do not adversely affect one another, so that an end product of high quality can be achieved overall.